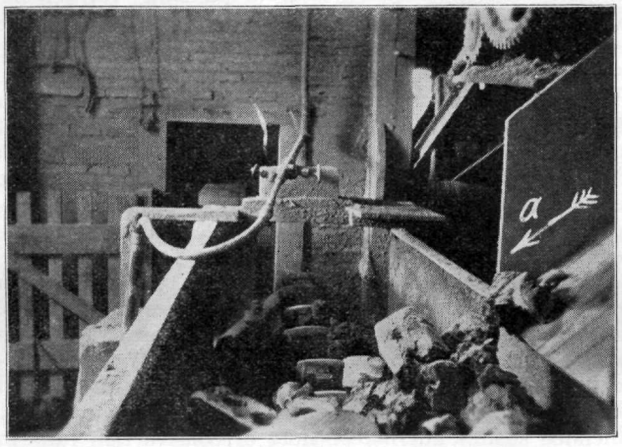
MANUFACTURING BUILDING BRICKS

By Raymond E. Birch, '27.

FROM its many crude beginnings the manufacture of bricks has been carefully studied and developed until at the present time there are, among advanced peoples, three general methods of producing building bricks. The methods are, the soft-mud process, the dry press process, and the third, which is the only one to be discussed here, is the stiff-mud process. Although there may be many relevant processes varying with the kind of clay used, these are usually associated with the stiff-mud process: (1) crushing, (2) pulverizing, (3) tempering, (4) molding, (5) drying, and finally (6) burning.



Pugmill with teeth shown protruding above clay. (a) Waste clay returned by belt from brick machine.

The common form of crusher consists of a toothed roller which revolves at the bottom of a shallow bin. It takes care of the clay in its crudest state and discharges it in lumps hardly as large as one's fist.

A bucket elevator carries the material to the dry pan, where two vertical wheels of great weight turn upon another wheel placed in a horizontal position. Here the clay is ground until is becomes fine enough to fall through the screen which surrounds the base wheel. Dry pans are recommended for shale, fire-clay, and other clay that can be ground without clogging the screens.

The screening process has been greatly improved by recent developments. Leaving the dry pan the finely ground clay is conveyed to copper screens which are kept constantly vibrating by an electro-magnet equipped with an interrupter.

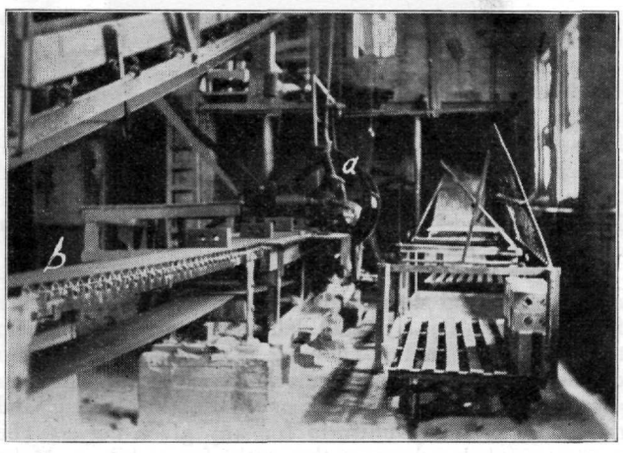
The clay in its pulverized form is ready for the pugmill, where it is tempered with water to permit of moulding. The pugmill (see illustration) is a rotating iron shaft with steel knives placed at regular intervals. After a thorough mixing the shaft forces the tempered clay from the rectangular frame (which incloses the pugmill) into the brick machine. Much responsibility rests upon the "pugman," since he must always secure the correct mixture of water and clay. An overabundance of water makes soft bricks which cannot be handled successfully, while too stiff a mixture does not mold readily.

Although this country was slow in improving upon old world processes of brick making, at the present time our's have no equal in any other nation. The first American brick machine, although crude indeed, was invented in 1835, and the succeeding years have beheld an extensive development. Modern stiff mud machines consist of, with variations, an auger which rotates within a cylinder, forcing the clay out through a small opening, thus giving it compactness. This mouthpiece or die through which the clay gains exit determines the shape of the product.

As the bar of clay is forced from the auger machine it is cut by steel wires into "green" bricks of the proper size, and these are moved on by an endless belt. Great care is taken with the green brick to preserve the corners and edges. The men who pick up the bricks from the belt to load them on steel drier cars are taught to eliminate pinching the soft bricks.

Many mistakes made at the brick machine are revealed only in burning the product. One difficult problem arises from the fact that stiff-mud bricks are apt to contain layers or laminations of varying densities which will either cause cracking in burning or scaling after the brick has been laid. This trouble has in a great part been eliminated by improved lubrication of the bar of clay in the machine, thus preventing the clay from hanging back around the outside of the die.

It is best to have the drier as near as possible to the brick machine, for the bricks are ready to be sent directly into the tunnel. We speak of tunnel because the drier which is most universal in its use consists of a series of tunnels, each equipped with a track for the cars of bricks. The tunnels are heated by a system of flues passing under them, from furnaces at one end to a stack at the other. An outlet from each tunnel must be provided for the water vapor which is given off in the process of drying.



Cutter room. (a) Cutter with brick machine in background; (b) conveyor.

Upon entering the receiving end of the drier tunnel the green bricks are met by and enveloped in a vapor laden air, since the only exit for moisture is at that end. This humid condition is advantageous since it does not permit the outside of the brick to dry prematurely, and thus resist the escape of moisture from the center of the bricks. As the car progresses through the tunnel and toward the source of heat, the temperature gradually raises, meeting changing needs of the clay.

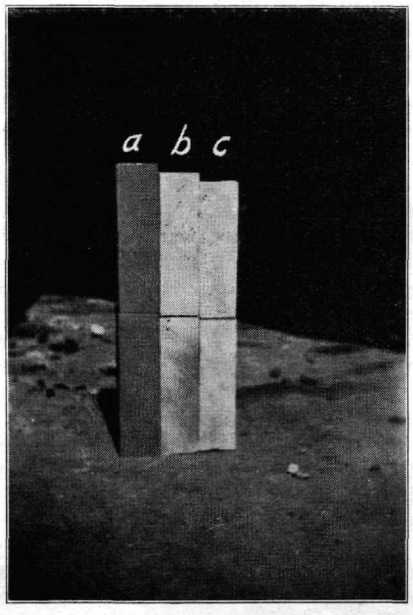
Following the drying, which requires from two to four

days, the bricks are transferred on the drier car directly to the kilns where they are unloaded and set.

Before an explanation of burning is attempted it is necessary to recall the various types of brick kilns. Although the general shape of the kiln may vary from circular to rectangular, the fundamental principles are nearly identical. Kilns for burning brick thoroughly are usually provided with flues arranged beneath a perforated floor and leading to the main chimney. Fire chambers designed for any fuel are placed along the sides of the kiln and the fire enters the kiln from behind walls of brick so as not to touch the bricks directly.

Various continuous kilns are now in use, and the latest kiln to be perfected is the railway tunnel kiln. By the latter process of burning, the ware loaded on cars is moved through a tunnel in which the fires remain stationary, and the waste heat is used for preheating the bricks.

Since all kilns are not equipped with pyrometers, the burner must acquire considerable ability in judging



Shrinkage and settle. (a) Green brick; (b) dried brick; (c) burnt brick.

heats. He knows that a certain color of heat in the kiln is necessary for the carbon burning period, and he realizes the maximum degree of whiteness that the brick can stand—the heat beyond which there is danger of the bricks becoming swollen.

The two infallible aids in brick burning are pyrometric cones and shrinkage. Segar pyrometric cones are formulated so that a certain definite heat will cause them to wilt over or curl. They are placed near the bottom of the kiln where they can readily be seen through a peep-hole. All bricks shrink or "settle" in burning, and this settle is fairly uniform for any given clay. The percentage being known, the settle for a kiln may be easily calculated. A small hole through the crown of the kiln permits the burner to measure the height of the bricks by means of an iron rod and a stationary marker.

Even though the drying has been thorough, an extended period of water-smoking is necessary, during which the temperature of the kiln is usually maintained between 200° F. and 400° F. Before the burning is begun in earnest the white steam will have disappeared from the chimney.

Experimentation from the crude beginning of brick burning to the present day has developed with finality the basic idea that in burning brick the method *must* be, *center first, surface last.* The moment the exterior is burned it changes form and resists the outward movement of waste from the center of the brick.

The temperature of the kiln is gradually raised so that the heat will have an opportunity to permeate the bricks. A heat of 1,500° F. to 1,700° F. should be maintained during about half the burning period. If a kiln should be taken on and rapidly raised to a high degree of heat, the head bricks would probably be drawn into the bag-walls, which are the walls extending in front of the fuel inlets. Bricks are also known to have run together when these intermediate temperatures were not utilized. After this carbon burning period is past, the bricks can be heated to their maximum burning temperature. This temperature is different for all clays, but seldom varies more than a few hundred degrees either above or below 2,000° F. This temperature is maintained until the cones melt, and until the desired settle is obtained. The firing now ceases and the kiln is allowed to begin cooling.

Cooling also is accomplished gradually in order to prevent "checking" or cracking of the ware. When the kiln is finally open several days are required with the aid of mechanical methods of cooling, in order that the shaders can begin sorting the bricks.

It is the burner's dream to secure an even burn from the top of the kiln to the bottom, but such a wish is yet to be realized. The head and top bricks are most often burned hard while among the lowermost bricks there are usually some "soft" ones. Bricks having been exposed to excessive heat are apt to be swollen and have curled edges.

Between the hard head bricks and the soft bottom ones there are many intermediate shades and grades. The present trend in brick buildings is toward the utilization of many of these shades on the same wall. Architects and building contractors, realizing the pitiful bleakness of mono-color walls, are urging the use of blended shades, for here beauty of construction falls in line with economy.

Chiefly because of their longevity and cheapness of upkeep, builders are now using *more brick*—the building material that is stronger than granite blocks.